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71 Applicant: **MEDINVENT S.A., Case Postale 549,  
CH-1001 Lausanne (CH)**

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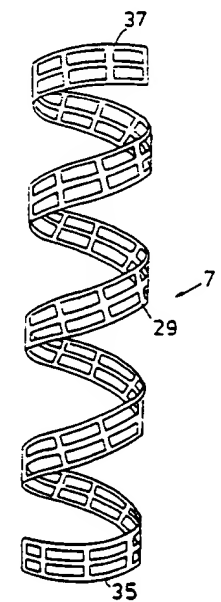
72 Inventor: **Kropf, Laurent, Chemin de la Velvy,  
CH-1349 Penthaiz (CH)**

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74 Representative: **Burman, Tore et al, Bergling &  
Sundbergh AB P.O. Box 7645, S-103 94 Stockholm (SE)**

54 **Coil spring for transluminal implantation and planar blank for the manufacture thereof.**

57 Planar blank (1; 3) intended for the manufacture of a coil spring (5; 7) suitable for transluminal implantation, characterized by an elongated, essentially straight mid section (9; 11) which at its ends passes over into end sections that are bent in the plane of the blank in opposite directions to form a blank having Z-shape, whereby a coil spring made from the blank (in which the spring material as seen in cross section has radially flattened shape) at its ends has a lower pitch than the mid section or no pitch at all; and a coil spring made from such blank.



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A planar blank and a coil spring manufactured therefrom.

The present invention relates to a planar blank intended for the manufacture of a coil spring suitable for transluminal implantation. The invention also includes the coil spring manufactured from the blank.

In surgical and other medicinal techniques there is often a need for being able to insert and expand devices in for example blood vessels, urinary tracts, respiratory tracts, intestinales or other difficultly accessible locations, said devices having for their function to widen the said vessel or duct and being capable of being left in position for providing permanent stability at the site of implantation.

In published British patent application 83 26791 there is disclosed a device which has for its purpose to provide the function indicated above. In this known device used for mechanical transluminal implantation, the prosthesis or spring means providing self-fixation by self-expansion at the site of implantation there are, however, certain practical problems in connection with the transluminal displacement. When inserted into for example a blood vessel the known coil spring is wound onto some elongated rod-shaped element and will then after the transluminal displacement be released at the desired location in the body. In this operation it is essential that the coil spring surrounds the carrier body very closely so that the surrounding walls of the vessel will not be damaged during the transluminal movement of the device. It is also essential that the coil spring when released and expanded at the site of implantation will be anchored in a reliable manner so that it will not later move from its position. The known device does not operate wholly satisfactorily in these two respects, and the present invention thus has for its purpose to provide an improved coil spring for transluminal implantation and a planar blank for the manufacture of the coil spring.

For this purpose the planar blank according to the pre-

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sent invention comprises an elongated, essentially straight midsection which at its ends passes over into endsections that are bent in the plane of the blank in opposite directions to form a blank having Z-shape. In this manner one obtains a coil spring made from the blank which at its ends has a lower pitch than at the midsection of the coil spring, and the coil spring may at its ends have no pitch at all. Using the planar blank the material of the manufactured spring obtains radially flattened shape as seen in crosssection.

For the purpose of enabling lower pitch and smaller distance between the turns in the midsection of the coil spring the midsection of the blank can be made smaller than the endsections as seen in the plane of the blank.

In order that the coil spring according to the invention shall find use as a filter for trombooses, for example by application in Vena Cava Inferior to prevent formation of lungemboli one endsection of the blank according to the invention can be extended as compared to the other one, so that in the coil spring made from the blank several overlapping turns are formed, which in a direction perpendicular to the centre line of the spring lie essentially in the same plane. In this context it is preferred that the extended endsection is made outwardly tapering for the purpose of reducing the flowresistance of the coil spring made from the blank.

In an alternative embodiment of the blank according to the invention both endsections are substantially of equal length and have a length less than the length of a complete turn in the coil spring made from the blank and in an unloaded state. Said length is suitably less than about  $3/4$  and preferably about  $1/2$  of said complete turn length.

The blank according to the invention is preferably over at least the major part of its length provided with through-going apertures as seen perpendicular to the plane of the blank, and said apertures are preferably arranged in at least one row extending in the longitudinal direction of the blank.

For providing a suitable shape of the coil spring made from the blank the endsections of the blank are suitably bent

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over an angle ( $\alpha$ ) lying within the range about  $5-40^\circ$ , preferably about  $10-30^\circ$  and particularly about  $10-25^\circ$ .

The coil spring according to the present invention has essentially helix shaped configuration, and its spring material as seen in an axial cross section is radially flattened. The coil spring is characterized by a midsection having a circular cylindric shape and endsections having, in relation to the midsection, lower pitch or pitch zero. In a corresponding manner as the blank according to the invention said midsection of the coil spring may be made from an axially smaller material than the material of the endsections.

For use as a filter of the coil spring as indicated above one endsection may consist of several turns which in a direction perpendicular to the centre line of the coil spring lie in essentially the same plane and which in a direction towards the free end of the endsection have a progressively decreasing radius of curvature. For the purpose of reducing the axial flow resistance of such coil spring the material of said one endsection is suitably made axially tapering towards the free end.

The coil spring according to the present invention may also be made substantially symmetrical, the material of the two endsections having essentially the same length, said length corresponding less than a full turn of the spring, preferably less than  $3/4$  turn.

For the purpose of facilitating the ingrowth of the coil spring in for example a blood vessel and thus to facilitate tissue growth the spring material over at least the major part of the spring is suitably provided with radially through-going apertures. It is particularly preferred that said openings have such an area that the main part of the remaining spring material has a tangential width of at most about 2.5 mm, preferably at most about 2 mm and particularly at most about 1.5 mm.

The material of the blank and the coil spring according to the present invention can be any medically acceptable

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material but is preferably constituted by a medicinally acceptable metal, for example of the type cobalt, chromium, nickel, molybdenum, iron alloy as defined in International Standard, ISO 5832/7-1984 (E). One example of such medicinally preferred metal alloy is Phynox® which alloy contains nickel, chromium, molybdenum, cobalt, silicon and manganese in an amount of 18, 20, 7, 40, 0.3 and 1.5% by weight respectively.

The coil spring and the blank according to the present invention offer substantial advantages as compared to the prior art. Thus, the coil spring starting from the blank according to the invention may be easier manufactured by winding on to a mandrel of a suitable diameter, since the bent endsections enable flat and even winding on to the mandrel. Moreover, the coil spring in transluminal implantation offers the major advantage that it can be wound on to a tubular or rod-shaped body to tight engagement thereon so that the transluminal displacement can be carried out without damages on surrounding tissue.

With regard to the thickness of the planar blank according to the invention it is, of course, depending on the size of the coil spring as manufactured and may therefore vary within broad limits. However, preferred thickness range is about 0.05 to 0.7 mm, preferably up to 0.5 mm. A particularly useful thickness range is about 0.1 to about 0.3 mm.

The invention will now be further described with reference to non-limiting examples and to the appended drawing, wherein:

Fig. 1 shows an embodiment of the blank according to the invention;

Fig. 2 shows in a sideview a coil spring made from the blank of Fig. 1, whereas

Fig. 3 shows the same spring in an endview;

Fig. 4 shows another embodiment of the blank according to the invention; and

Fig. 5 shows in a sideview a coil spring manufactured from the blank of Fig. 4.

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The blank shown in Fig. 1 and generally indicated 1 has a straight midsection 9 and an elongated endsection 13 bent in relation to the midsection 9, and another endsection 15 bent in relation to the midsection 9 in the opposite direction. The blank thereby forms somewhat straightened Z-shape. Over the major part of its length blank 1 is provided with through-going apertures 21, which in the embodiment shown form two longitudinally extending rows 23, 25 in the midsection, one endsection 15 and part of the other endsection 13. The elongated endsection 13 is made outwardly tapering for a purpose to be further explained below.

In Figs. 2 and 3 there is shown a coil spring made from the blank of Fig. 1 and generally designated 5. This coil spring has in a corresponding manner as the blank a midsection 27 and endsections 31, 33, of which the endsection 31 corresponding to the elongated endsection 13 of the blank of Fig. 1 forms a spiral lying in one plane having a progressively decreasing radius of curvature towards the centre (see Fig. 3). The other endsection is constituted by about half a springturn with a pitch which is substantially zero.

The coiled spring shown in Fig. 2 may thus be used as a filter for thromboses in bloodvessels, for example by application in Vena Cava Inferior so that one may thereby prevent formation of lungemboli. By the elongated endsection 13 provided with a tapering shape there is obtained the advantage that the axial resistance to flow of the coil spring will be reduced in direction towards the centreline of the coil spring. In this manner unacceptable deviation of the filter part 31 of coil spring 5 when blood flows through the spring will be prevented. By designing the coil spring with endsections 31, 33 having a pitch of zero the spring obtains in connection with its implantation a more stable anchorage in the surrounding walls of the vessel and collapse will thus effectively be prevented. By designing the spring with through-going apertures 21 the tissue growth in the surrounding walls of the vessel will be substantially facilitated.

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The blank of the invention shown in Fig. 4 and generally designated 3 consists in a similar manner of a midsection 11 and endsections 17,19. The blank is, moreover, provided with through-going apertures 21. In the embodiment shown a  
5 midsection 11 is provided with lower width in order to enable winding with closer turns and thus lower pitch in the coil spring made from the blank.

In Fig. 5 there is shown a coil spring manufactured from the blank of Fig. 4 consisting of a midsection 29 and  
10 endsections 35,37, the later sections having a pitch of about zero. The length of each of these endsections 35,37 is about half turn of the spring.

The embodiment of the invention shown in Figs. 4 and 5 offers the same advantages as the filtervariant described  
15 earlier and may advantageously be used in transluminal implantation for example to support deficit bloodvessels or to stabilize respiratory tract and bronchi.

It should be observed that the invention is not limited to the embodiments described above which are solely intended  
20 to illustrate the invention, the invention being limited only by the scope of the appended patent claims.

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CLAIMS

1. Planar blank (1;3) intended for the manufacture of a coil spring (5;7) suitable for transluminal implantation, characterized by an elongated, essentially straight mid section (9;11) which at its ends passes over into end sections that are bent in the plane of the blank in opposite directions to form a blank having Z-shape, whereby a coil spring made from the blank (in which the spring material as seen in cross section has radially flattened shape) at its ends has a lower pitch than the mid section or no pitch at all.
2. Blank according to claim 1, characterized in that the mid section (11) as seen in the plane of the blank is smaller than the end sections (17,19) to enable the corresponding part (29) of the coil spring made from the blank to have a lower pitch and thereby smaller distance between the turns in said part.
3. Blank according to claim 1 or 2, characterized thereby that one end section (13) is extended as compared to the other one, so that in the coil spring thus manufactured several overlapping turns (31) are formed which in a direction perpendicular to the centre line of the spring lie essentially in the same plane.
4. Blank according to claim 3, characterized thereby that said end section (13) is made outwardly tapering for the purpose of reducing the flow resistance of the coil spring (5) made from the blank.
5. Blank according to claim 1 or 2, characterized thereby that both end sections (17,19) are substantially of equal length and have a length less than the length of a complete turn in the coil spring made from the blank in an unloaded state.
6. Blank according to claim 5, characterized thereby that said length is less than about  $3/4$ , preferably about  $1/2$  of said complete turn length.
7. Blank according to any preceding claim, characterized thereby that over at least the major part of its length it is provided with through-going apertures (21) as seen perpendicular to the plane of the blank.



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8. Blank according to claim 7, characterized thereby that said apertures (21) are arranged in at least one row (23,25) extending in the longitudinal direction of the blank.

9. Blank according to any preceding claim, characterized thereby that the end sections (13,15;17,19) are bent over an angle ( $\alpha$ ) lying within the range about 5-40°, preferably about 10-30°, especially about 10-25°.

10. Coil spring (5,7) suitable for transluminal implantation and having essentially helix-shaped configuration, the spring material of same being radially flattened as seen in an axial cross section, characterized by a mid section (27,29) of circular cylindric shape and end sections (31,33;35,37) having, in relation to the mid section, lower pitch or a pitch of zero.

11. Coil spring according to claim 10, characterized thereby that said mid section (29) is made from an axially smaller material than the material of the end sections (35,37).

12. Coil spring according to claim 10 or 11, characterized thereby that one end section (31) consists of several turns which in a direction perpendicular to the centre line of the coil spring (5) lie in essentially the same plane and which in a direction towards the free end of the end section have a progressively decreasing radius of curvature.

13. Coil spring according to claim 12, characterized thereby that the material of said one end section (31) is made axially tapering towards the free end for the purpose of reducing the axial flow resistance of the coil spring.

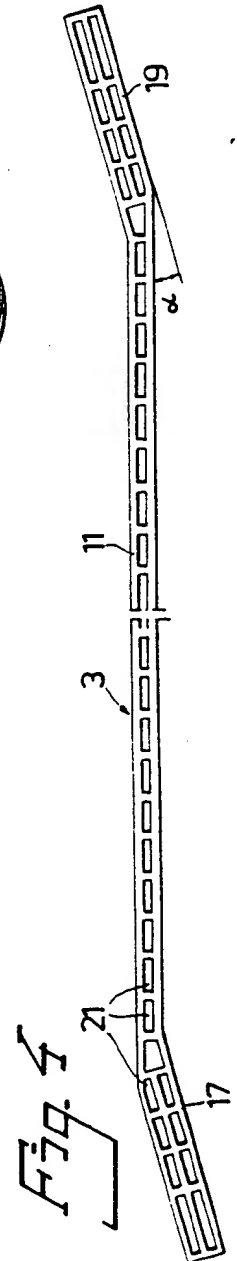
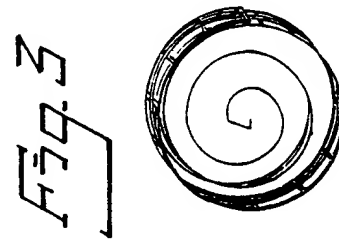
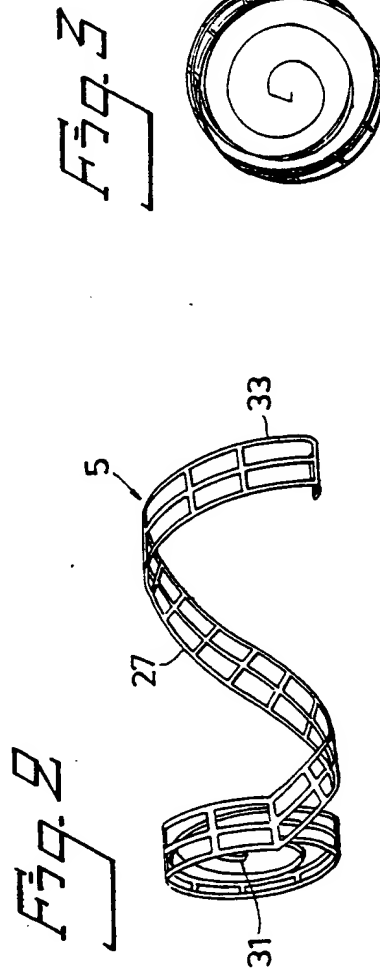
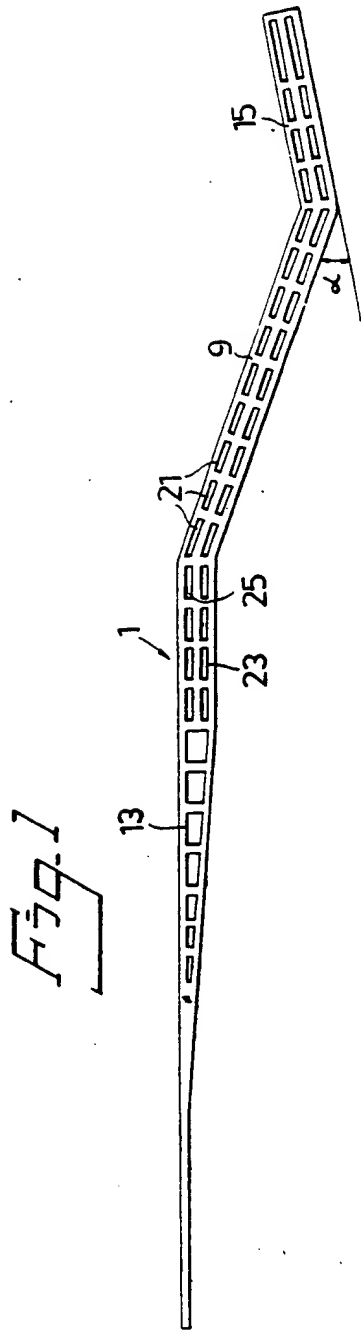
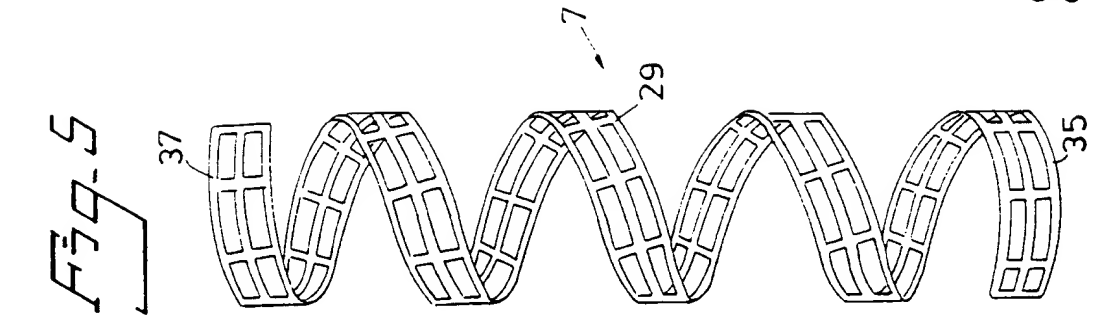
14. Coil spring according to claim 10 or 11, characterized thereby that the material of the two end sections (35,37) has essentially the same length, said length corresponding to less than a full turn of the spring (7).

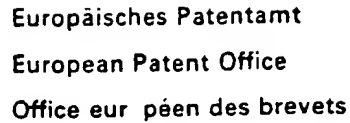
15. Coil spring according to claim 14, characterized thereby that the end sections (35,37) each extend over less than about 3/4 turn.

16. Coil spring according to any of claims 10-15, characterized thereby that the spring material over at least the major part of the spring is provided with radially through-going apertures (21).

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17. Coil spring according to claim 16, characterized  
thereby that said apertures (21) cover such an area that the  
main part of the remaining spring material has a tangential  
width of at most about 2,5 mm.





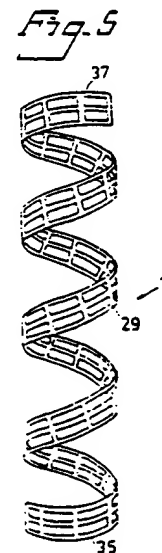
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74 Representative: Burman, Tore et al.  
Bergling & Sundbergh AB P.O. Box 7645  
S-103 94 Stockholm(SE)

57) Planar blank (1, 3) intended for the manufacture of a coil spring (5, 7) suitable for transluminal implantation, characterized by an elongated, essentially straight mid section (9, 11) which at its ends passes over into end sections that are bent in the plane of the blank in opposite directions to form a blank having Z-shape, whereby a coil spring made from the blank (in which the spring material as seen in cross section has rapidly flattened shape) at its ends has a lower pitch than the mid section or no pitch at all; and a coil spring made from such blank.



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European Patent  
Office

# EUROPEAN SEARCH REPORT

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Application number

EP 86 85 0107

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
D, A	WO-A-8 300 997 (H. I. WALLSTEN et al.) * Page 12, lines 14-19, page 24, lines 11-22; claims 3, 5, 9; figures 6, 7, 22, 25 *	1, 4, 7, 8	A 61 F 2/04
D, Y		10, 12, 16, 17	
Y	DE-A-2 528 273 (K. FABIAN) * Column 3, line 33 - column 4, line 6; figure 2 *	10, 12, 16, 17	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			A 61 F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28-07-1987	Examiner WOLF C.H.S.
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			